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The effectiveness of eye movement desensitization and reprocessing toward anxiety disorder: A meta-analysis of randomized controlled trials

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ABSTRACT

Background: Eye Movement Desensitization and Reprocessing (EMDR) has been well established as an effective treatment for post-traumatic stress disorder (PTSD). However, PTSD has been re-categorized as part of trauma and stressor-related disorders instead of anxiety disorders. We conducted the first meta-analysis on Randomized Controlled Trials to evaluate the effectiveness of EMDR on reducing symptoms of anxiety disorders.

Methods: A manual and systematic search using various databases and reference lists of systematic review articles published up to December 2018 was conducted. The symptoms of anxiety, phobia, panic, traumatic feelings and behaviors/somatic symptoms were examined. Hedges' *g* effect sizes were computed, and random effect models were used for all analyses.

Results: A total of 17 trials with 647 participants were included in this meta-analysis. EMDR was associated with a significant reduction of anxiety ($g = -0.71$; 95% CI: -0.96 to -0.47), panic ($g = -0.62$; 95% CI: -1.10 to -0.14), phobia ($g = -0.45$; 95% CI: -0.81 to -0.08), behavioural/somatic symptoms ($g = -0.40$; 95% CI: -0.63 to -0.12), but not traumatic feelings ($g = -0.48$; 95% CI: -1.14 to -0.18). Subgroup analysis revealed greater effects of EMDR if compared to passive control. However, the effects were not significantly different based on the duration, number of therapy sessions, or the number of weekly sessions.

Conclusions: Our meta-analysis indicates that EMDR is efficacious for reducing symptoms of anxiety, panic, phobia, and behavioural/somatic symptoms. Further research is needed to explore EMDR's long term efficacy on anxiety disorders.

1. Introduction

Anxiety disorders are the most frequently occurring mental health disorders across the lifespan. Worldwide, at least 264 million people suffer from anxiety disorders (WHO, 2017b). An annual report from the World Health Organization stated that from 2005 to 2015, the number of cases increased by 14.9% (WHO, 2017a). A global study conducted in 44 countries demonstrated that 1 in 14 (73%) people experienced an anxiety disorder at any given time (Baxter et al., 2014). Another study revealed that 6.7% of people had anxiety disorders at a specific period of their life, and 12.9% experienced anxiety disorders during their whole life (Steel et al., 2014). Approximately 7% of suicide mortality in the age group between 15 and 49 years was associated with anxiety disorders. In total, 10% of the global suicide burden is associated with anxiety disorders (Baxter et al., 2014). With anxiety disorder prevalence rates and consequences continuously increasing, anxiety

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disorders should be a significant concern for clinicians globally.

Eye movement desensitization and reprocessing (EMDR) can be considered as the latest therapy among psychological interventions developed to counter mental health conditions, specifically anxiety disorders. Francine Shapiro developed EMDR based on the Adaptive Information Processing model to assist the processing of traumatic memories with bilateral eye stimulations (Landin-Romero et al., 2018). Unlike other psychotherapies, EMDR has eight phases that involve behavioral, cognitive, and physical components and is known as an integrative psychotherapeutic approach (as it involves active elements from various psychotherapeutic approaches such as empathic listening, cognitive restructuring, psychoeducation). Specifically, the eight phases are (I) Patient History and Treatment Planning; (II) Preparation; (III) Assessment; (IV) Desensitization; (V) Reprocessing; (VI) Body Scanner; (VII) Closure; and (VIII) Re-assessment (Coubard, 2016; Landin-Romero et al., 2018; Shapiro, 2014). EMDR works by distracting and reconstructing past traumatized memory through eye movements, while the patient concentrates on getting desensitized to the memory. The process of EMDR extracts all the anxious feelings and leads to a decrease in vividness and emotionality in regards to memory; this approach reconstructs patients' cognitive thinking, along with their emotional status which in turn helps the patient to process the memory and emotions correctly. According to Shapiro (2014) the founder of EMDR, "the positive therapeutic outcomes (of EMDR) rapidly achieved without homework or detailed description of the disturbing event offer the medical community an efficient treatment approach with a wide range of applications."

Initially, EMDR was developed to treat anxiety disorders, particularly for Post-Traumatic Stress Disorders (PTSD) (Coubard, 2016; Shapiro, 1989). However, the revision of the 2010 Diagnostic and Statistical Manual of Mental Disorders (DSM) re-categorized PTSD as part of trauma and stressor-related disorders instead of anxiety disorders (Zoellner et al., 2011). The effectiveness of EMDR toward traumatic disorders, either post-traumatic stress disorder (PTSD) or acute stress disorder, has been demonstrated in numerous meta-analysis (Albright and Thyer, 2009; L. Chen, Zhang, Hu and Liang, 2015; R. Chen et al., 2018; Y. R. Chen et al., 2014; Davidson and Parker, 2001; C. W. Lee and Cuijpers, 2013; Moreno-Alcazar et al., 2017; Seidler and Wagner, 2006; Valiente-Gomez et al., 2017). Recently the application of EMDR as psychotherapy is no longer restricted to traumatic disorders. Several studies have been conducted to verify its efficacy in other mental health conditions such as anxiety, depression, phobia, and panic disorder (Bauman and Melnyk, 1994; Cook-Vienot and Taylor, 2012; Doering et al., 2013; Feske and Goldstein, 1997; Foley and Spates, 1995; Goldstein et al., 2000; Gosselin and Matthews, 1995; Homer and Deeprose, 2018; Horst et al., 2017; Jong et al., 1997; Littel, Remijn, Tinga, Engelhard, & Van den Hout, 2017; Lytle et al., 2002; Muris et al., 1998; Passoni et al., 2018; Rathschlag and Memmert, 2014; Zeighami et al., 2018). Despite numerous previous studies, limited efforts have been invested in conducting a meta-analysis focused on the effectiveness of EMDR towards anxiety disorders. As the first meta-analysis to analyze EMDR from a different perspective, the primary purpose of this study was to measure the effectiveness of EMDR towards anxiety disorders based on previous randomized controlled trials (RCTs).

2. Methods

2.1. Identification and selection of studies

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. A comprehensive literature search of all articles published from the beginning of the databases up to December 2018 through CINAHL, Cochrane, Embase, Ovid, Scopus, PubMed, and Google Scholar databases. The search used medical subject headings (MeSHS) terms including: "eye movement desensitization and reprocessing" or "EMDR," "anxiety disorders," and "generalized anxiety disorder" or "GAD" or "phobia" or "panic disorder" and set a filter for RCT studies only.

The eligibility criteria for the current meta-analysis were studies that had a RCT design and tested the effectiveness of EMDR on anxiety disorders. This search was conducted according to the PICO (Population, Intervention, Comparison, and Outcomes) tool endorsed by the Cochrane Collaboration (Higgins and Green, 2008). We included all populations with anxiety disorders who received EMDR as a treatment therapy. The diagnosis could be made either clinically, based on diagnostic criteria, or with a score above the cut-off point on a self-report measure. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), the classification of anxiety disorders has changed drastically compared with the previous version. Currently, anxiety disorders include generalized anxiety disorder, social anxiety disorder, selective mutism, panic disorder, agoraphobia, and specific phobias. Studies with mixed diagnoses participants were included as long as anxiety disorder was the primary diagnosis. For the type of intervention, studies were included if they reported EMDR as the psychotherapy either in individual or group format. For comparison, any therapies including Therapy as Usual (TAU), waiting list-control, or another control psychological treatment were included in the study. In case a study was compared between two or more types of control groups, the effect size of EMDR was calculated against the passive control such as the waiting list or TAU. For outcomes, studies were included if they measured at least one of the following symptoms: anxiety, phobia, panic, behavioral/somatic and traumatic feelings. Only studies that were parallel randomized controlled trials were included. We excluded studies in which EMDR was combined with other forms of therapy or pharmacological interventions and studies that did not provide sufficient statistics for effect size calculations. Studies were not limited based on specific participant age or language. While searching for prospective studies, we supplemented the results by hand searching of meta-analyses and review articles.

2.2. Data extraction and risk of bias

The information extracted from the articles was organized by participant characteristics (sample size, age, and gender), diagnosis characteristics (criteria to diagnose and diagnosis), intervention characteristics (experiment and control group interventions' type, the amount of sessions, duration of each session, frequency in a week, and total time of therapy), and outcomes (outcome indicators and assessment tools). One investigator extracted data and results were confirmed by another investigator before they were transferred and analyzed with a Comprehensive Meta-Analysis program (Version 3.0; Biostat Inc).

All included articles underwent a risk of bias (RoB) assessment using the Cochrane Handbook for Systematic Reviews of Interventions Version 2.0 to assess the quality. Two independent researchers assessed the RoB independently. There were five domains with potential risks of bias as follows: randomization process, deviation from intended intervention, missing outcome data, measurement of the outcome, and selection of the reported results. The assessment of bias was performed to conclude either the article had a low risk, some concern, or a high risk of bias. If disagreement occurred, a third party was included until consensus was reached through discussion. The Cohen's k for inter-rater reliability for the research quality assessment was 0.88.

2.3. Outcome measures

We analyzed outcome data on symptoms of anxiety, phobia, panic, behavioral/somatic and traumatic feelings. Some studies used more than one instrument to measure the same symptom. In terms of that situation, we selected the most frequently used measures across studies. As the primary outcome, the symptoms of anxiety were measured using; Test Anxiety Inventory (TAI) (Bauman and Melnyk, 1994; Cook-Vienot

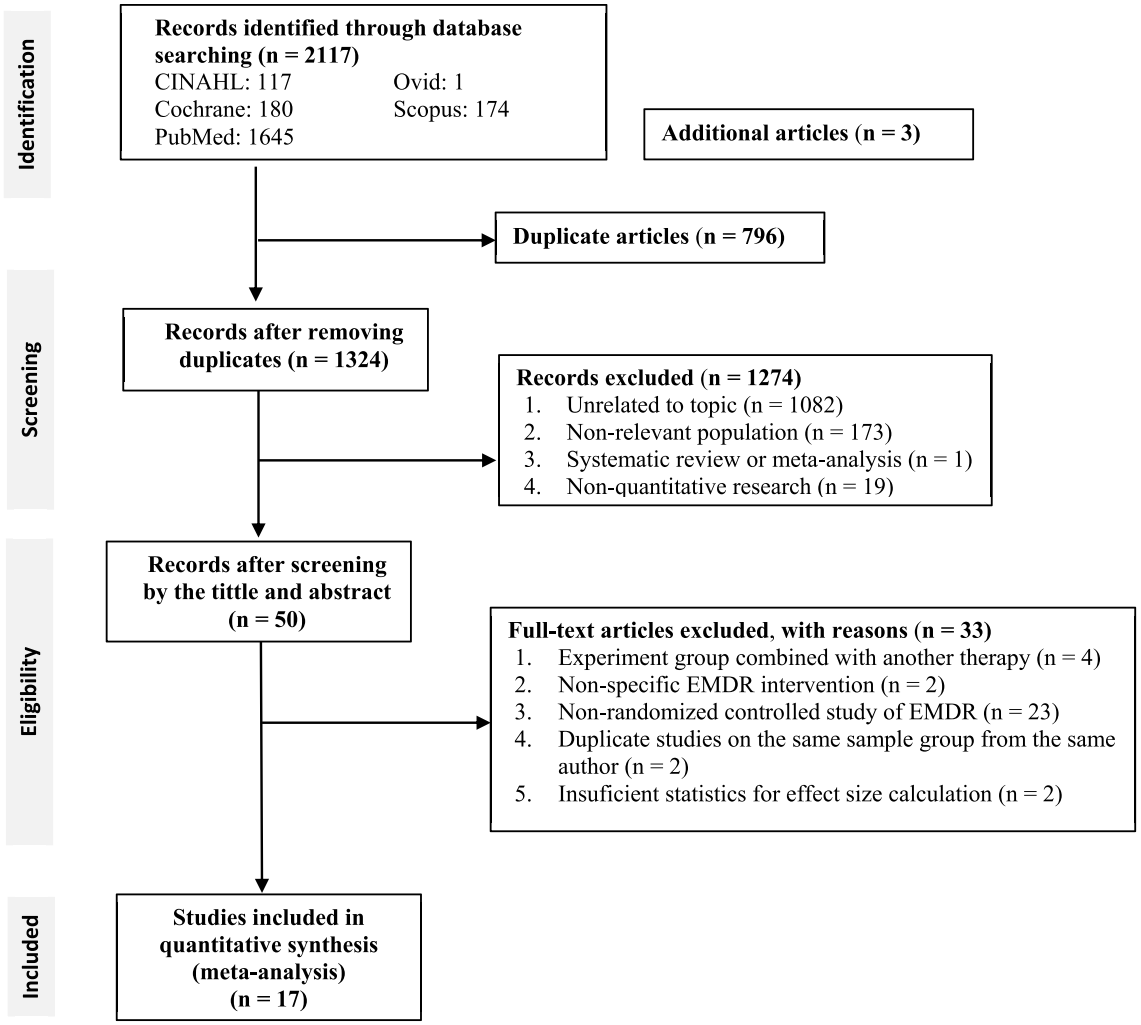


Fig. 1. PRISMA flow diagram.

and Taylor, 2012; Gosselin and Matthews, 1995); Dental Anxiety Scale (DAS) (Doering et al., 2013); Beck Anxiety Inventory (BAI) (Feske and Goldstein, 1997; Goldstein et al., 2000; Zeighami et al., 2018); The Personal Report of Communication Anxiety-24 (PRCA-24) (Foley and Spates, 1995); Body Sensations Questionnaire (BSQ1) (Horst et al., 2017); Visual Analog Scale (VAS) (Littel et al., 2017); Anxiety and Depression Scale-Reduce (AD-R) (Passoni et al., 2018); State-Trait Anxiety Inventory (STAI) (Rathschlag and Memmert, 2014); State Anxiety-Behavioural Avoidance Test (SA-BAT) (Muris et al., 1998); and Hospital Anxiety Depression Scale (HADS) (Rahimi et al., 2018). Symptoms of phobia, panic disorder, somatic, and traumatic feelings were secondary outcomes. The symptoms of phobia were assessed using: Dental Fear Survey (DFS) (Doering et al., 2013); Agoraphobic Cognitions Questionnaire (ACQ) (Feske and Goldstein, 1997; Goldstein et al., 2000; Horst et al., 2017); Spider Phobia Questionnaire (SPQ) (Muris et al., 1997); Spider Phobia Questionnaire for Children (SPQ-C) (Muris et al., 1998); Agoraphobia Questionnaire (APQ) (Cook-Vienot and Taylor, 2012); and Imagery Fearsomeness rating (IFR) (Bates et al., 1996). Behavioral/somatic symptoms were measured by using: Brief Symptoms Inventory (BSI) (Doering et al., 2013; Feske and Goldstein, 1997); The Brief Body Sensations Interpretation Questionnaire (BBSIQ) (Goldstein et al., 2000); Body Sensations Questionnaire (BSQ) (Horst et al., 2017); and Behavioural Avoidance Test (BAT) (Muris and Merckelbach, 1997; Muris et al., 1997, 1998). Panic Appraisal Inventory (PAI) (Feske and Goldstein, 1997; Goldstein et al., 2000) and Impact Event Scale revision (IES-R) (Doering et al., 2013; Passoni et al., 2018)were the only tools used to assess symptoms of panic disorders and traumatic feelings respectively.

2.4. Publication bias

Publication bias only applied to the primary outcome of anxiety. Egger's regression intercept (Egger et al., 1997) and Begg rank correlation were used for examining publication bias. Egger's linear regression utilizes a logarithmic scale to analyze the funnel plot's asymmetry. A high correlation in Begg's test would indicate that the funnel plot is asymmetric. An asymmetric shape of the funnel plot would indicate the presence of publication bias.

2.5. Statistical analysis

Effect sizes (Hedges' *g*) were calculated for the difference between the baseline and post-treatment effects for both the EMDR and the control group. We did not analyze the differences between baseline and follow-up data because only four out of 17 articles conducted repeated measurements. Comprehensive Meta-Analysis software program version 3.0 was used to determine the treatment effect along with the effect size using a random-effects model. This approach was the most suitable because the effect size may vary among studies, which could lead to heterogeneity (Ahn and Kang, 2018; Barili et al., 2018; Y. H. Lee, 2018). Hedges' *g* was considered as the reference to calculate the effect size. The value of Hedges' *g* 0.2, 0.5, and 0.8 represent small,

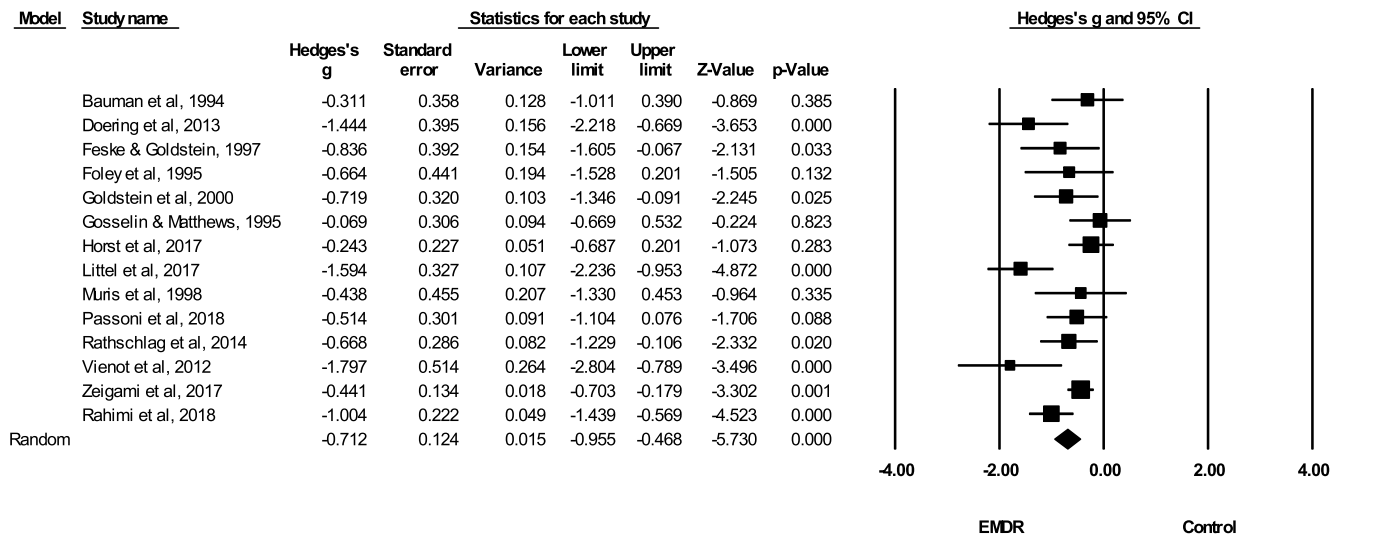


Fig. 2. Effectiveness of EMDR toward symptoms of anxiety (n = 14).

medium, and large effect sizes.

Heterogeneity of effect sizes was based on Cochrane's *Q* or *Q* statistics and I^2 statistic and a *p*-value of < 0.05. The degree of heterogeneity was divided into three levels, 25%, 50%, and 75%, corresponding to low, moderate, and high estimates, respectively. Considering that Cochrane's *Q* has low statistical strength, a *p*-value of < 0.05 indicated heterogeneity (Y. H. Lee, 2018).

In the presence of heterogeneity, further analyses were required to determine the variance and moderating variables. EMDR therapy characteristics (duration of therapy, number of therapy sessions, the total time of therapy, type of control group therapy), and patients' characteristics (age and gender) were potential variables that could influence the effect size. A mixed-effects model was used to determine the effect size, *Q* statistics, and *p*-value between categorical variables, and a two-sided *p*-values was used for continuous variables. A significant *p*-value of < 0.05 indicated the potential effects as moderator variables.

3. Results

3.1. Description of studies

As presented in the PRISMA flow chart in Fig. 1, 2120 studies were retrieved during the initial search and the total decreased to 1324 after checking for duplicates. From there, records were screened by the title and abstract and 1274 studies were excluded because they were unrelated to the topic (1082), measured the effect of EMDR to other disorders population (173), was a meta-analysis (1), or were non-quantitative studies (19). After screening the full text of the remaining studies, two studies were excluded for insufficient statistical data, and 31 were excluded based on the study protocol (EMDR combined with another therapy, no specific information regarding EMDR, non-RCT design, and multiple articles from the same study). Of the remaining RCTs, 17 studies met the eligibility criteria and were analyzed in the meta-analysis.

3.2. Study characteristics

The 17 studies were conducted between 1994 and 2018, with a total of 647 people ranging from 14 to 90 participants in each study. The samples were aged between 9 and 84 years old with the average age of patients ranging from 11.55 to 66.07. Most of the samples were adults (83%) and predominantly females (72.3%). More than half of studies diagnosed the patients based on either DSM-III or IV (53%), and patients met the criteria for anxiety (47%), while the remaining were diagnosed with a phobia, panic disorder, or a combination of disorders. Three studies included patients with mixed diagnoses including anxiety-phobia, panic-phobia, and phobia-agoraphobia. A total of 327 patients were treated with EMDR and 320 were in various control groups. Fourteen studies (82.4%) measured symptoms of anxiety, while six studies (38.9%) measured phobia, nine studies (50%) measured behavioral/somatic symptoms, and symptoms of panic and traumatic feelings were measured in two studies (11.1%) each. In terms of therapy characteristics, 88.2% were individual therapies, 41.1% had more than one control group, and 76.5% used a passive control group. The remaining studies included an active control group with various types of psychotherapy including Cognitive Behavioral Therapy (CBT), eye fixation, exposure, and finger tapping. The application time for EMDR in all studies varied widely from 30 min to 120 min for each session, up to twice a week, and the total amount of sessions ranged

from 1 to 13 sessions (Appendix 1).

3.3. Risk of bias

With regard to the risk of bias, two studies (11.8%) exhibited a low RoB, 11 studies (64.7%) had some concern of bias, and four remaining studies (23,5%) had a high RoB (Appendix 1). Most studies did not report data related to the RoB because of concealment in the randomization process. However, 3 out of the 17 studies clearly stated the concealment procedure. Not all articles followed the criteria to avoid the risk of bias so, the quality of the studies varied.

3.4. Publication bias

The funnel plot for all studies measuring anxiety symptoms displayed a symmetrical shape. The distribution between studies was relatively balanced for both sides. Egger's regression test and Begg's rank correlation indicated that were was no publication bias with a $p < 0.05$.

3.5. Efficacy analysis

3.5.1. The effect of EMDR on the primary outcome (anxiety symptoms) between pre-and-post treatment

In the 14 studies that measured symptoms of anxiety, EMDR demonstrated a significant effect ($p = 0.000$) with a Hedges' g score of -0.71 and 95% CI from -0.96 to -0.47 (Fig. 2). Therefore, EMDR had a high effect size. The results remained significant after the sensitivity analysis was conducted by removing one study. Moderate heterogeneity was detected in the analysis of EMDR toward anxiety ($Q = 30.68$, $p = 0.000$, $I^2 = 57.63\%$) (Table 1).

3.5.2. The effect of EMDR on the secondary outcomes (phobia, panic, behavioral/somatic symptom, and traumatic feelings) between pre-and-post treatment

We measured four secondary outcomes being measured in this study, symptoms of phobia, panic, behavioral/somatic symptoms, and traumatic feelings. The results indicated a considerable effect of EMDR toward phobia symptoms ($p = 0.018$) with a Hedges' g score of -0.45 (95% CI -0.81 to -0.08) (Fig. 3). The results from the test of heterogeneity indicated that EMDR had a moderate degree of heterogeneity in phobia symptoms ($Q = 10.43$, $p = 0.11$, $I^2 = 42.48\%$). EMDR showed a moderate effect on symptoms of panic with ($p = 0.011$) with a Hedges' g score of -0.62 (95% CI -1.10 to -0.14) and no heterogeneity was detected with regards to symptoms of panic ($Q = 0.17$, $p = 0.68$, $I^2 = 0\%$). All results remained stable after the sensitivity analysis was conducted. This meta-analysis also revealed that EMDR significantly reduced behavioral/somatic symptoms ($p = 0.000$) with a small effect size with a Hedges' g score of -0.40 (95% CI -0.63 to -0.12). The heterogeneity indicated that EMDR had no heterogeneity in behavior/somatic symptoms ($Q = 3.93$, $p = 0.86$, $I^2 = 0\%$) (Appendix 2). On the other hand, EMDR displayed no significant effect on traumatic feelings with $p = 0.154$ (95% CI -1.14 to 0.18).

3.5.3. Moderator analysis

We selected only the studies that reported symptoms of anxiety outcomes for the subgroup analysis (n = 14). Studies were only included if they reported the type of control group therapy (active and passive therapy), the number of therapy sessions (< and ≥3 sessions), therapy duration (< and ≥90 min), and weekly therapy sessions (< and ≥ 3 sessions). A meta-regression analysis was conducted to measure the number of sessions, duration of each session and sample size as moderators of EMDR toward anxiety level.

Subgroup analysis results revealed that EMDR had a stronger effect (Hedges' $g = -0.92$) when compared to the passive control group than to the active control group (Hedges' $g = -0.56$), with a between-group significance of $p = 0.003$. By contrast, the results demonstrated that EMDR was not significantly different if delivered < 3 sessions (Hedges' $g = -0.63$) or ≥ 3 sessions (Hedges' $g = -0.76$) with $p = 0.647$. The same result also found when EMDR delivered in < 90 min (Hedges' $g = -0.77$) or ≥90 min (Hedges' $g = -0.61$) in each session with p = 0.558. Even though the result did not indicate statistical significance, EMDR did demonstrate a larger effect when delivered in <90 min that may be clinically significant. Our analysis of EMDR showed a non-significant difference if delivered in < or ≥ 3 sessions in a week (Hedges' $g = -0.72$) with $p = 0.647$.

Meta-regression analyses were conducted for all potential moderators to evaluate their impact on the effectiveness of EMDR toward anxiety. However, no statistically significant relationship was observed between the effect size of anxiety and the sample size ($\beta = 0.003$, $p = 0.58$), total therapy sessions ($\beta = 0.032$, $p = 0.31$), duration of each session ($\beta = 0.003$, $p = 0.51$), and number of weekly sessions ($\beta = 0.032$, $p = 0.31$) (Table 2).

4. Discussion

The main purpose of this study was to determine the effectiveness of EMDR specifically towards anxiety disorders. Symptoms of anxiety was the primary outcome, and symptoms of phobia, panic, behavioral/somatic symptoms and traumatic feelings were the secondary outcomes in the present study.

4.1. Effectiveness of EMDR on anxiety symptoms

Our meta-analysis revealed that EMDR has a moderate effect size on symptoms of anxiety as the primary outcome. While our findings do support a previous meta-analysis of EMDR for PTSD conducted by Chen and colleagues in 2014 (Y. R. Chen et al., 2014), which found a moderate effect on anxiety (g = −0.640) in PTSD patients. However, our population of study is those specifically with anxiety disorders. Our meta-analysis reveals that EMDR is an effective therapy to treat anxiety symptoms even though EMDR was developed specifically for the PTSD population. Previous studies demonstrate that the exposure to

Table 1
Overall effect size of EMDR on patients with anxiety disorders.

Symptoms	No. of studies	Hedges' g (95% CI)	Null hypothesis test (2 tailed)		Homogeneity test		
			Z	p	Q value	p	I^2
Primary outcome							
Anxiety	14	−0.71 (−0.96 to −0.47)	−5.73	**0.000**	30.68	0.004	57.63%
Secondary outcomes							
Phobia	7	−0.45 (−0.81 to −0.08)	−2.38	0.018	10.43	0.11	42.48%
Panic	2	−0.62 (−1.10 to −0.14)	−2.53	**0.011**	0.17	0.68	0%
Behavioral/Somatic symptoms	9	−0.40 (−0.63 to −0.12)	−2.14	**0.000**	3.93	0.86	0%
Traumatic Feeling	2	−0.48 (−1.14 to 0.18)	−1.43	0.154	2.10	0.15	52.44%

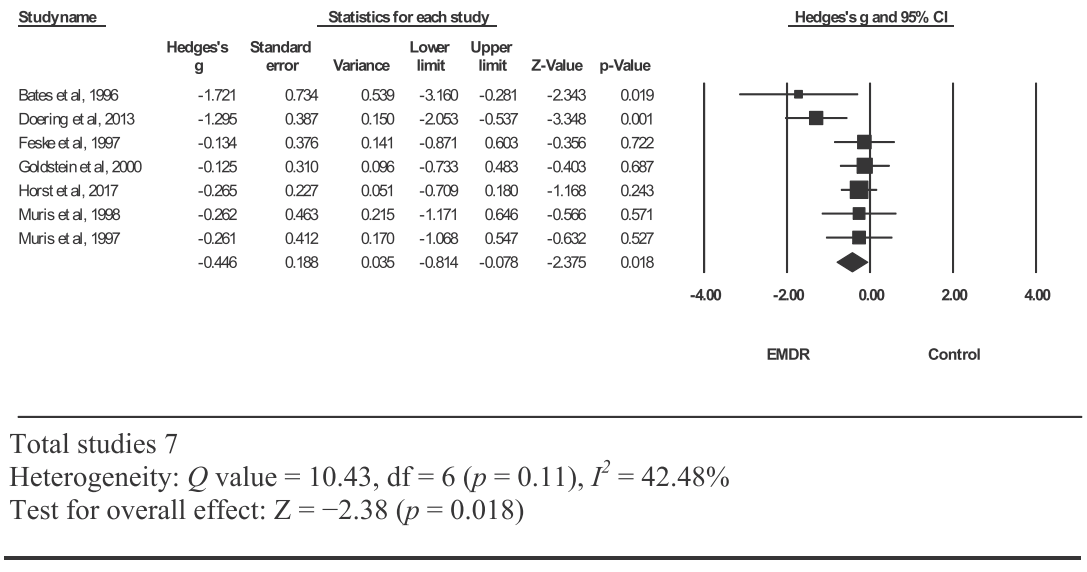


Fig. 3. Effectiveness of EMDR toward symptoms of phobia (n = 7).

traumatic events is highly associated with anxiety disorders (Ayazi et al., 2014).

DSM-5 mentions that traumatic stress symptoms are highly associated with other mood disorders, substance abuse, anxiety, trauma, and other mental disorders. Given that the essential aspects of anxiety are relatively similar to stress-related trauma, EMDR has a positive effect on both disorders. The very first trial of EMDR revealed that this therapy was an effective approach to decrease anxiety symptoms by up to 70% compared with the control group through the Subject Unit Distress (SUD) measurement before and after treatment (Shapiro, 1989). Anxiety act as a signal of danger, threatful, or motivational situations. Anxiety results in the expression of a range of *flight or fight* response. People who feel anxiety will activate autonomic nervous system including the sympathetic nervous system and Hypothalamic Pituitary-Adrenal (HPA) axis. An activation of HPA axis results on increasing secretion of glucocorticoid hormones such as cortisol and adrenaline into circulation. The transient release of cortisol and adrenaline result in advantageous physiologic adaptation to help individual survive from short-term stressful situation. As well as cortisol, adrenaline through activate sympathetic nervous system increasing the heart-lung activation, blood sugar level, and blood volume at muscle-brain level. In the appearance and measurable symptoms, people with anxiety will shows tremors of the muscle, tachycardia, hyperventilation, and flushed face (Levitt, 2015; Stahl and Moore, 2013). From psychological perspective, fear or anxiety is a result from learning experience. Anxiety disorders has a strong correlation to past stressful experience (Ayazi et al., 2014; Muris, 2006; Newman et al., 2013; Shapiro, 2014; Stevenson et al., 1992). Stressful or traumatized experience improperly stored in memory as negative cognition, emotion, along with it's physical sensations. Anxious feeling suggest that the information processing

Table 2
Moderator analysis EMDR to anxiety symptoms.

Variables	No. of studies	Hedges' g (95% CI)	Null hypothesis test (2 tailed)		Homogeneity test	
			Z	*p*	*Q* value	*p*
Subgroup analysis						
Type of control therapy						
Active	5	−0.28 (−0.56 to 0.00)	−1.939	0.052	8.89	**0.003**
Passive	9	−0.92 (−0.78 to −0.36)	−5.83	0.000		
Duration of each session						
< 90 min	7	−0.77 (−1.23 to −0.30)	−3.22	0.001	0.34	0.558
≥90 min	7	−0.61 (−0.83 to −0.40)	−5.57	0.000		
Number of therapy sessions						
< 3 sessions	6	−0.63 (−1.09 to −0.17)	−2.70	0.007	0.21	0.647
≥3 sessions	8	−0.76 (−1.06 to −0.45)	−4.88	0.000		
Weekly sessions						
< 3 sessions/week	6	−0.63 (−1.09 to −0.17)	−2.70	0.007	0.21	0.647
≥3 sessions/week	8	−0.76 (−1.06 to −0.45)	−4.88	0.000		

Variables	**No. of studies**	b_0	b_1	**95% CI**	**Z**	***p***
Number of therapy sessions	14	−0.87	0.032	−0.032 to 0.095	−1.02	0.31
Duration of each session	14	−0.96	0.003	−0.006 to 0.013	0.66	0.51
Sample size	14	−0.86	0.003	−0.008 to 0.014	0.55	0.58
Weekly sessions	14	−0.87	0.032	−0.029 to 0.095	1.02	0.31

system has stored without adequately processing it to an adaptive resolutions. To be successful interact with the environment, individual rely on the knowledge in their memory due how to react to particular stimuli, as consequence people with anxiety tend to avoid the stressor or anxious source.

Eye movement and emotions are linked because they share a common neural circuitry, but the exact underlying neural mechanism of EMDR is still unclear (Coubard, 2016). However, a study by Pagani et al. (2012) to determine the neurobiological process before, during and post EMDR intervention found that bilateral ocular stimulation or saccadic eye movement in EMDR activated the rostal Prefrontal Cortex (rPFC) (Pagani et al., 2012). As part of the limbic system, the rPFC is thought to be involved in processing emotional value of new information and trauma response. Based on a physiological perspective, the sensory stimulation in EMDR repairs the thalamic and thalamic-cortical functions as well as facilitates the repair of maladaptive neural linkage of information processing (Bergmann, 2000; Landin-Romero et al., 2018). Shapiro (1989) suggested that the dual-attention task creates OR and physiological de-arousal which aids in information processing of traumatic memories. Research have shown that participants in EMDR therapy had lower heart rates, respiration rates and skin conductance compared to participants in the control group (Elofsson et al., 2008; Sack et al., 2008). These changes are compatible with an increased parasympathetic contribution to autonomic activity.'

EMDR acts by distracting and reconstructing memory through eye movements while the patient concentrates on the memory to desensitize. It extracts all the anxious feelings and leads to a decrease in vividness and emotionality. This approach reconstructs patients' cognitivity along with their emotional status. Based on a physiological perspective, the sensory stimulation in EMDR repairs the thalamic and thalamo-cortical functions as well as facilitates the repair of maladaptive neural linkage of information processing. As the ability to process new information improves, people tend to have a positive perspective toward new information and to proceed it as non-threatening. DSM-5 straightly mentions that traumatic stress symptoms are highly associated with other mood disorders, substance abuse, anxiety, trauma, and other mental disorders. Given that the essential aspects of anxiety are relatively similar to stress-related trauma, EMDR has a positive effect on both disorders. The very first trial of EMDR by Shapiro in 1989 revealed that this therapy was an effective approach to decrease anxiety symptoms up to 70% compared with the control group through Subject Unit Distress (SUD) measurement before and after treatment. It confirms that, originally, EMDR was developed not only to treat traumatic symptoms but also other stress-related disorders.

4.2. Effectiveness of EMDR on symptoms of panic

As part of anxiety disorders, panic symptoms are commonly associated with previous traumatic events and characterized by recurrent unexpected panic attacks and hyperarousal symptoms such as heart palpitations, sweating, trembling or shaking (American Psychiatric Association, 2000). Although only two studies measured the effect of EMDR on panic symptoms, our meta-analysis demonstrated a significant effect. According to The Adaptive Information Processing (AIP) model, EMDR assumes that panic occurs when people are unable to process and react to stressful events appropriately. Inadequately processed traumatic experiences may impair resilience and increase vulnerability to future occurring experiences. These experiences form a bucket of overwhelming responses that are trapped and stored in the memory network. The panic memories in panic disorders are very similar to the traumatic memories in PTSD. The orientating response theory may also help to explain the effect of EMDR on symptoms of panic (Horst et al., 2017). The bilateral movement of the eyes may activate an "investigate reflex" which could produce a deactivation of alert response with an absence of threat (Denny, 1995). In this way, EMDR helps patients with panic symptoms to suppress emotional disturbance and to become less sensitive and find ways to control those negative emotions.

4.3. Effectiveness of EMDR on symptoms of phobia

Similar to panic symptoms, phobias have remarkable commonalities with PTSD, as the source of fear or phobic stimuli may have a strong correlation with past traumatic experiences, and the person demonstrates an excessive or unreasonable amount of fear of objects or situations (de Jongh et al., 2006). Our meta-analysis also revealed that EMDR had a positive effect on reducing phobia symptoms. In the AIP model, unprocessed past traumatic thoughts, emotional, and body sensations are stored and stay in the memory network. In EMDR therapy, the phase of desensitization especially helps people with phobias to release their negative memories as well as strengthen positive cognition to replace the negative thoughts caused by an adverse experience. As the ability to process new information improves, people tend to have a positive perspective towards new information and can now process the information as non-threatening (Bergmann, 2000; Coubard, 2016; Landin-Romero et al., 2018). This explains the strong effect of EMDR on symptoms of phobia.

4.4. Effectiveness of EMDR on behavioral/somatic symptoms

Our meta-analysis found that EMDR also displayed a significant effect on behavioral/somatic symptoms with a small effect size. This finding is similar to a previous systematic review conducted in 2009, which involved 16 studies that determined the effectiveness of EMDR toward Medical Unexplained Symptoms (MUS). This study found EMDR to be effective in treating chronic pain, phantom limb pain, seizure, fatigue, body dysmorphic, as well as sleep, visual, and myoclonic movement problems (van Rood and de Roos, 2009). Another study found the following MUS: Irritable bowel syndrome (IBS), non-ulcer dyspepsia (NUD), fibromyalgia (FM), and chronic fatigue syndrome (CFS), to be significantly correlated with anxiety disorders compared to healthy person and people with medical disorders of known organic pathology (Henningsen et al., 2003).

According to the Adaptive Information Processing (AIP) model, the existence of somatic symptoms is highly correlated to the emotional and physical sensations inherent of unprocessed traumatic memory (Shapiro, 1989, 2014). There are two possible explanations of how EMDR works in suppressing somatic symptoms; first, physical complaint occurs during the traumatic or stressful event will be stored in the memory. The inadequate process of stressful and traumatic events stored will leave the person in a vulnerable condition. Any stimulus that constitutes a potential threat manifests in physical re-experience and change the automatic response related to traumatized memory (van Rood and de Roos, 2009). EMDR can help individuals to process the dysfunctional memory that could decrease the intensity of somatoform complaints. Second, most of the people with chronic anxiety experience a diminished range or variability of physiologic responses to the stressor, known as Diminished Physiologic Flexibility (DPF) (Hoehn-Saric et al., 2004). The existence of previous traumatic experiences heightened the sensitivity of bodily sensations and autonomic arousal levels. DPF may represent inadequate attempts of the body to adapt to the physiologic changes induced by anxiety. People with anxiety experience somatic symptoms more easily because of their diminished ability to adapt to stimuli. Through EMDR, people with anxiety disorders who experience somatic symptoms learn to be more focused on external or internal stimuli and expand the range of physiological responses. EMDR works by separating the connections between traumatic memories and physical sensations in the neurophysiology of the limbic system. As a consequence, individuals experience their memories with less distress and behavioral shifts (Grant and Threlfo, 2002).

4.5. Effectiveness of EMDR on symptoms of traumatic feelings

EMDR initially was developed specifically to treat traumatized patients. However, this study showed different results. In our meta-analysis, EMDR showed no significant effect on symptoms of traumatic feelings. This may be due to the small number of eligible studies, as only two studies focused on symptoms of traumatic feelings that delivered EMDR in an individual format. The studies consist of 67 participants and both studies compared EMDR to the waiting list control. The small number of studies might have affected the overall effect size. Additionally, both studies had some concerns of risk of bias.

4.6. Moderators of the effect

We performed a subgroup analysis for the primary outcome of anxiety symptoms. The analysis was based on EMDR therapy characteristics (therapy sessions and therapy duration), the type of comparison group, and the age of the participants. Based on therapy characteristics, EMDR exhibited a stronger effect if compared to the passive control group than to the active control group. The findings in this study provide further evidence on what Coubard found. Coubard (2016) differentiated the control group therapies according to the validated or non-validated psychotherapies. Non-validated treatments refer to not well-defined or not standardized methods such as Image Habitual Training, Biofeedback, Relaxation, and active listening of traumatic history, while validated treatments refer to CBT for PTSD. Coubard (2016) found that EMDR demonstrated a better result if compared with the non-treatment or non-validated treatment group instead of well-validated psychotherapies. Whilst in this meta-analysis, control groups were divided into passive and active. Passive control group refer to no treatment and delayed treatment and active control groups consisted of various types of activities such as finger tapping, eye desensitization, eyes fixed, CBT, and exposure *in vivo*, and most of these active control groups are known and validated psychotherapies.

Our subgroup analysis also revealed that the effectiveness of EMDR when was delivered in < 3 or ≥ 3 sessions was not significantly different. In this meta-analysis, approximately eight studies delivered a single session of EMDR, three studies had eight sessions, one study had 13 sessions, and the rest were between two and six sessions. EMDR developed by Shapiro was initially designated to be delivered in eight sessions, however there was variation in numbers of sessions delivered in different clinical settings in the included studies in this meta-analysis. Evidence from previous studies has demonstrated that EMDR has a positive effect when delivered in three sessions (Shapiro, 2014). In addition, the symptoms and diagnosis severity of participants could have influenced the difference in the number of therapy sessions in the included studies and those without complex or severe symptoms may not have needed a longer therapy program. A short series of therapy sessions may have economic benefit due to their low-cost nature; however, therapeutic effects of treatment should be considered before financial cost. As each individual has different needs, precision psychiatry should be taken into consideration to tailor the right therapy for the right patient. This study showed that EMDR's effect in reducing symptoms of anxiety was not significantly different if delivered in $<$ 90 min or $\geq$90 min. The duration of EMDR therapy varied in the included studies, but in general the EMDR sessions are conducted between 50 and 90 min, depending on the participant's condition. Marcus et al. (1997) demonstrated that an average of 50 min of EMDR had therapeutic effects on PTSD. Furthermore, the results of the moderator analysis revealed that age, number of therapy sessions, therapy duration, sample size, and weekly therapy sessions were not significant moderator variables across the samples and therapy characteristics. These results were consistent with results from subgroup analysis. Therefore, the results of our meta-analysis suggest that EMDR is widely applicable to many populations and remains highly significant in various formats.

4.7. Limitation

This study has several limitations that should be taken into account when interpreting the results. First, only a limited number of studies were included in this study due to the fact that many RCT studies continue to focus on determining the efficacy of EMDR on PTSD and not on anxiety disorders. Although the minimum number of studies included in a meta-analysis is two well-powered articles (Turner et al., 2013), the small number of studies included might limit the generalizability of the findings. Second, the fact that we excluded some studies that combined EMDR with other therapies in this meta-analysis, may have resulted in inflated or deflated effect size estimates. Third, regarding the risk of bias, we included studies with various levels risk of bias and most of the studies had 'some concern' of bias.

5. Conclusion

Notwithstanding the limitations, our meta-analysis is the first to determine the effectiveness of EMDR specifically for anxiety disorders. We conducted a comprehensive analysis of all symptoms under anxiety disorders including anxiety, phobia, and panic with an additional two other outcomes. Our results provide evidence in support of the efficacy of EMDR beyond PTSD, especially in reducing symptoms of anxiety, phobia, panic, and behavioral/somatic along with subgroup analysis based on the number of sessions, duration, and type of control therapy. Further studies are needed to explore EMDR efficacy to explore EMDR's long term efficacy on anxiety disorders.

5.1. Implication

This meta-analysis revealed that EMDR in clinical settings can reduce symptoms of anxiety, phobia, and behavioral/somatic among those who are diagnosed with anxiety disorders. Furthermore, our meta-analysis indicated that EMDR could be delivered either less than or at least three sessions and less or more than 90 min long.

CRediT authorship contribution statement

Ninik Yunitri: Data curation, Formal analysis, Software, Visualization, Writing - original draft. **Ching-Chiu Kao:** Software, Validation. **Hsin Chu:** Software, Validation. **Joachim Voss:** Validation, Writing - review & editing. **Huei-Ling Chiu:** Formal analysis, Validation. **Doresses Liu:** Software, Validation. **Shu-Tai H. Shen:** Software, Validation. **Pi-Chen Chang:** Software, Validation. **Xiao Linda Kang:** Validation, Writing - review & editing. **Kuei-Ru Chou:** Conceptualization, Supervision, Validation, Writing - review & editing.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2020.01.005.

Appendix 1. Characteristic of Randomized Controlled Trials (RCTs) included in the meta-analysis (N = 17)

No	Study Citation	Participant Diagnosis	Participants	Group type (E/C)	Intervention character-izaion Format/Frequency	Outcome indicator & Measurement tools		RoB (Cochrane 2.0)
						Outcome	Follow up	
1	Bates et al. (1996)	**Criteria for diagnosis**: DSM–III–R **Diagnosis**: Phobia	**Sample size** Total: 14 E: 8 C: 6 **Mean age**: **Gender** Male: Female: 14	E: EMDR C: No Treatment	**Format**: Individual **Frequency**: Session: 1 Duration: 75–90 min Days of week: 1x/week Total weeks: 1 Total times: 75–90 min	**Phobia:** IFR	None	High Risk
2	Bauman et al, 1994	**Criteria for diagnosis**: Cut point of TAI **Diagnosis**: Anxiety	**Sample size** Total: 30 **Mean age**: **Gender** Male: 1 Female: 29	E: EMDR C: Finger tapping	**Format**: Individual **Frequency**: Session: 1 Duration: 45 min Days of week: 1x/week Total weeks: 1 Total times: 45 min	**Anxiety:** TAI	None	High Risk
3	Cook-Vienot and Taylor, 2012	**Criteria for diagnosis**: Cut point of Symptoms checklist-90-R **Diagnosis**: Anxiety	**Sample size** Total N: 20 E: 10 C: 10 **Mean age**: 36.9 **Gender** Male: NA Female: NA	E: EMDR C: TAU	**Format**: Individual **Frequency**: Session: 4 Duration: 45–75 min Days of week: NM Total weeks: NM Total times: 4.5 h	**Anxiety:** TAI **Behaviour/Somatic symptoms**: APQ	None	Some Concern
4	Doering et al. (2013)	**Criteria for diagnosis**: DSM-IV-TR **Diagnosis**: Phobia	**Sample size** Total: 31 E: 16 C: 15 **Mean age**: 40.97 **Gender** Male: 5 Female: 26	E: EMDR C: waiting list	**Format**: Individual **Frequency**: Session: 3 Duration 90 min Days of week: 1x/week Total weeks: 3 Total times: 4.5 h	**Phobia:** DFS **Anxiety:** DAS **Behaviour/Somatic symptoms**: BSI **Traumatic feeling:** IES-R	3 months 12 months	Some Concern
5	Feske & Goldstein, (1997)	**Criteria for diagnosis**: DSM–III–R SCID **Diagnosis**: Phobia complicated with agoraphobia	**Sample size** Total N: 27 E: 15 C: 12 **Mean age**: 35.2 **Gender** Male: NA Female: NA	E: EMDR C: Waiting list	**Format**: Individual **Frequency**: Session: 5 Duration: Session 1: 120 min Session 2–5: @ 90 min Days of week: 2x/week Total weeks: 3 Total times: 8 h	**Phobia:** ACQ **Anxiety:** BAI **Behaviour/Somatic symptoms:** BSI **Panic:** PAI	3 months	Some Concern
6	Foley and Spates, 1995	**Criteria for diagnosis**: ADIS-R PRCA-24 **Diagnosis**: Anxiety and phobia	**Sample size** Total: 20 E: 10 C: 10 **Mean age**: 18 **Gender** Male: 2 Female: 18	E: EMDR C: No intervention	**Format**: Individual **Frequency**: Session: 2 Duration: 45 min Days of week: NM Total weeks: NM Total times: 1.5 h	**Anxiety:** PRCA-24	None	High Risk
7	Goldstein et al. (2000)	**Criteria for diagnosis**: DSM-IV **Diagnosis**: Panic disorder with agoraphobia	**Sample size** Total N: 40 E: 20 C: 20 **Mean age**: 38.16 **Gender** Male: NA Female: NA	E: EMDR C: Waiting list	**Format**: Individual **Frequency**: Session: 8 Duration: 90 min Days of week: 2x/week Total weeks: 4 Total times: 12 h	**Phobia:** ACQ **Anxiety:** BAI **Behaviour/Somatic symptoms:** BBSIQ **Panic:** PAI	None	Some Concern
8	Gosselin & Matthews, (1995)	**Criteria for diagnosis**: Cut point of TAI **Diagnosis**: Anxiety	**Sample size** Total: 41 **Mean age**: 21.1 **Gender** Male: 11 Female: 30	E: EMDR C: No Movement	**Format**: Individual **Frequency**: Session: 1 Duration: 60 min Days of week: 1x/week Total weeks: 1 Total times: 60 min	**Anxiety:** TAI	None	Some Concern
9	Horst et al. (2017)	**Criteria for diagnosis**: SCID-I primary diagnosis of PD **Diagnosis**: Panic	**Sample size** Total: 77 E: 39 C: 38	E: EMDR C: CBT	**Format**: Individual **Frequency**: Session: 13 Duration: 60 min	**Phobia:** ACQ **Anxiety:** BSQ1 **Behaviour/Somatic symptoms:** BSQ2	3 months	Low Risk

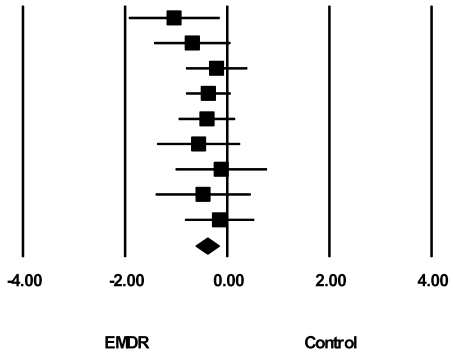
			Mean age: 39 **Gender** Male: 22 Female: 55		Days of week: 1x/week Total weeks: 13 Total times: 20 h			
10	Littel et al. (2017)	**Criteria for diagnosis**: PRCA-24 **Diagnosis**: Anxiety	**Sample size** Total: 48 E: 24 C: 24 **Mean age**: 21.22 **Gender** Male: 0 Female: 48	E: EMDR C: TAU	**Format**: Individual **Frequency**: Session: 1 Duration: 30 min Days of week: 1x/week Total weeks: 1 Total times: 30 min	**Anxiety:** VAS **Behaviour/somatic symptoms:** Hearth rate	None	Some Concern
11	Muris et al. (1997)	**Criteria for diagnosis**: DSM-IV **Diagnosis**: Phobia	**Sample size** Total 16 E: 8 C: 8 **Mean age**: 33.40 **Gender** Male: Female: 16	E: EMDR C: No treatment	**Format**: Individual **Frequency**: Session: 1 Duration: 90 min Days of week: 1x/week Total weeks: 1 Total times: 1.5 h	**Behaviour/somatic symptoms:** BAT	None	Some Concern
12	Muris et al. (1997)	**Criteria for diagnosis**: DSM-III **Diagnosis**: Specific Phobia	**Sample size** Total 22 E: 11 C: 11 **Mean age**: 11.55 **Gender** Male: Female: 22	E: EMDR C: Exposure *in vivo*	**Format**: Individual **Frequency**: Session: 1 Duration: 90 min Days of week: 1x/week Total weeks: 1 Total times: 1.5 h	**Phobia:** SPQ **Behaviour/somatic symptoms:** BAT	None	High Risk
13	Muris et al. (1998)	**Criteria for diagnosis**: DSM–III–R **Diagnosis**: Phobia	**Sample size** Total: 17 E: 9 C: 8 **Mean age**: 12.58 **Gender** Male: 0 Female: 17	E: EMDR C:Computerize exposure group	**Format**: Individual **Frequency**: Session: 1 Duration: 90 min Days of week: 1x/week Total weeks: 1 Total times: 1.5 h	**Phobia:** SPQ-C **Anxiety:** State anxiety-BAT **Behaviour/somatic symptoms:** BAT	None	High Risk
14	Passoni et al. (2018)	**Criteria for diagnosis**: Cut point of SUD **Diagnosis**: Post-traumatic, emotional symptoms (anxiety, burden, depression)	**Sample size** Total: 44 E: 22 C: 22 **Mean age**: 66.07 **Gender** Male: 10 Female: 34	E: EMDR C: Waiting list	**Format**: Group **Frequency**: Session: 8 Duration: 120 min Days of week: 1x/week Total weeks: 2 months Total times: 16 h	**Anxiety:** AD-R **Traumatic feelings:** IES-R	2 months 4 months	Some Concern
15	Rahimi et al. (2018)	**Criteria for diagnosis**: Cut point of HADS **Diagnosis**: Anxiety & Depression	**Sample size** Total 90 E:45 C: 45 **Mean age**: 51.52 **Gender** Male: 43 Female: 47	E: EMDR C: TAU	**Format**: Individual **Frequency**: Session: 6 Duration: 30–45 min Days of week: 2x/week Total weeks: 4 Total times: 3–4.5 h	**Anxiety:** HADS	None	Low Risk
16	Rathschlag et al. (2014)	**Criteria for diagnosis**: NA **Diagnosis**: Anxiety	**Sample size** Total N: 50 E: 25 C: 25 **Mean age**: 23.30 **Gender** Male: 22 Female: 28	E: EMDR C: Waiting list	**Format**: Group **Frequency**: Session: 1 Duration: 90 Days of week: 1x/week Total weeks: 1 total times: 1.5 h	**Anxiety:** STAI	None	Some Concern
17	Zeigami, R et al. (2017)	**Criteria for diagnosis**: Cut point of BAI **Diagnosis**: Anxiety	**Sample size** Total: 60 E: 30 C: 30 **Mean age**: 47.62 **Gender** Male: 39 Female:21	E: EMDR C: TAU	**Format**: Individual **Frequency**: Session: 8 Duration: 45-90 Days of week: 2x/week Total weeks: 1 months total times: 12 h	**Anxiety:** BAI	**None**	Some Concern

Diagnostics: DSM-III = Diagnostic Statistics Manual III; DSM-IV-TR = Diagnostic Statistics Manual IV Revised; SCID = Structured Clinical Interview for DSM; ADIS-R = Anxiety Disorders Interview Schedule-Revised.

Interventions: EMDR = Eye Movement Desensitization and Reprocessing; TAU = Therapy As Usual; CBT = Cognitive Behaviour Therapy.
Instruments: IFR = Imagery Fearsomeness rating; TAI = Test Anxiety Inventory; APQ = AgoraPhobia Questionnaire; DFS = Dental Fear Survey; DAS = Dental Anxiety Scale; BSI = Brief Symptoms Inventory; IES-R = Impact Event Scale-Revised; ACQ = Agoraphobic Cognitions Questionnaire; BAI = Beck Anxiety Inventory; PAI = Panic Appraisal Inventory; PRCA-24 = The Personal Report of Communication Anxiety-24; BBSIQ = The Brief Body Sensations Interpretation Questionnaire; BSQ = Body Sensations Questionnaire; VAS = Visual Analog Scale; STAI = State-Trait Anxiety Inventory; IES = Impact Event Scale.
BAT = Behavioural Avoidance Test; SPQ-C = Spider Phobia Questionnaire for Children; SA-BAT = State Anxiety-BAT; AD-R = Anxiety and Depression Scale-Reduce, HADS = Hospital Anxiety Depression Scale.

Appendix 2. Effectiveness of EMDR toward Behavioral/somatic symptoms (n = 9)

Model	Study name	Statistics for each study						
		Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
	Cook-Vienot et al, 2012106.6	-1.037	0.459	0.210	-1.936	-0.138	-2.262	0.024
	Feske et al, 1997	-0.684	0.387	0.150	-1.442	0.074	-1.768	0.077
	Goldstein, et al, 2000	-0.206	0.311	0.097	-0.815	0.403	-0.662	0.508
	Horst et al, 2017	-0.369	0.228	0.052	-0.815	0.077	-1.623	0.105
	Little et al, 2017	-0.397	0.287	0.082	-0.959	0.166	-1.382	0.167
	Muris et al, 1997	-0.559	0.419	0.175	-1.379	0.262	-1.334	0.182
	Muris et al, 1998	-0.117	0.462	0.213	-1.022	0.787	-0.254	0.799
	Muris & Merckelbach, 1997	-0.470	0.480	0.230	-1.410	0.471	-0.978	0.328
	Doering et al, 2013	-0.149	0.351	0.123	-0.836	0.538	-0.424	0.672
Random		-0.402	0.115	0.013	-0.626	-0.177	-3.503	0.000



Total studies 9
Heterogeneity: Q value = 3.93, df = 8 (p = 0.860), I^2 = 0%
Test for overall effect: Z = −2.14 (p = 0.000)

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